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# Development and Characterization of Fiber – Reinforced Thermoset Composites

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**ABSTRACT:** Now-a-days, the natural fibres and fillers from renewable natural resources offer the potential to act as a reinforcing material for polymer composite material alternative to the use of natural fibres and other man-made fibres. Among various natural fibres and fillers like aramid, wheat straw, rice husk, wood powder, jute, hemp etc. are the most widely used natural fibres and fillers due to its advantages like easy availability, low density, low production cost and reasonable physical and mechanical properties. This research work presents the effects of natural fillers, hybrid composite structure is formed. The result of test depicted that hybrid composite has far better properties than single fibre glass reinforced composite under impact and flexural loads. However, it is found that the hybrid composite has better strength as compared to single glass fibre composites. This research project develops into the exploration of advanced fiber composites and their significance in aerospace engineering applications. The study focuses on assessing the mechanical properties, such as tensile strength, modulus of elasticity, and fatigue resistance, of various fiber-reinforced composites, including carbon fiber, glass fiber, and aramid fibre.

**KEYWORDS:** Fiber, Reinforced composites, Glass fiber.

## I. INTRODUCTION

### 1.1 COMPOSITE

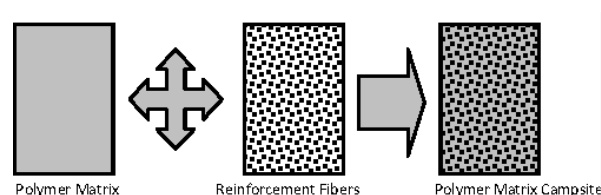
A composite material is made by combining two or more materials – often ones that have very different properties. The two materials work together to give the composite unique properties. However, within the composite you can easily tell the different materials apart as they do not dissolve or blend into each other.

### 1.2 TYPES OF COMPOSITE

Generally, the composite material classified three types, there are

- Polymer matrix composite
- Metal matrix composite
- Ceramic matrix composite

#### 1.2.1 Polymer Matrix Composite



Polymers make ideal materials as they can be processed easily, possess lightweight, and desirable mechanical properties. It follows, therefore, that high temperature resins are extensively used in aeronautical applications. Two main kinds of polymers are thermosets and thermoplastics. Thermosets have qualities such as a well-bonded three-dimensional molecular structure after curing. They decompose instead of melting on hardening. Merely changing the basic composition of the resin is enough to alter the conditions suitably for curing and determine its other characteristics. They can be retained in a partially cured condition too over prolonged periods of time, rendering Thermosets very flexible. Thus, they are most suited as matrix bases for advanced conditions fiber reinforced composites. Thermosets find wide ranging applications in the chopped fiber composites form particularly when a premixed or moulding compound with fibers of specific quality and aspect ratio happens to be starting material as in epoxy, polymer and phenolic polyamide resins. Thermoplastics have one- or two-dimensional molecular structure and they tend to at an elevated temperature and show exaggerated melting point. Another advantage is that the process of softening at elevated temperatures can reversed to regain its properties during cooling, facilitating applications of

conventional compress techniques to mould the compounds. Resins reinforced with thermoplastics now comprised an emerging group of composites. The theme of most experiments in this area to improve the base properties of the resins and extract the greatest functional advantages from them in new avenues, including attempts to replace metals in die-casting processes. In crystalline thermoplastics, the reinforcement affects the morphology to a considerable extent, prompting the reinforcement to empower nucleation. Whenever crystalline or amorphous, these resins possess the facility to alter their creep over an extensive range of temperature. But this range includes the point at which the usage of resins is constrained, and the reinforcement in such systems can increase the failure load as well as creep resistance. Figure 1.1 shows the preparation of composite

### 1.2.2 Metal Matrix Composite

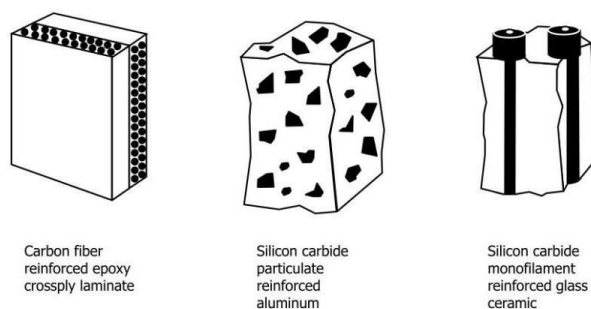


Figure 1.3 Preparation of Metal Matrix Composite

Metal matrix composites, at present though generating a wide interest in research fraternity, are not as widely in use as their plastic counterparts. High strength, fracture toughness and stiffness are offered by metal matrices than those offered by their polymer counterparts. They can withstand elevated temperature in corrosive environment than polymer composites. Most metals and alloys could be used as matrices and they require reinforcement materials which need to be stable over a range of temperature and non-reactive too. However the guiding aspect for the choice depends essentially on the matrix material. Light metals form the matrix for temperature application and the reinforcements in addition to the aforementioned reasons are characterized by high moduli. Most metals and alloys make good matrices. However, practically, the choices for low temperature applications are not many. Only light metals are responsive, with their low density proving an advantage. Titanium, Aluminium and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. If metallic matrix materials have to offer high strength, they require high modulus reinforcements. The strength-to weight ratios of resulting composites can be higher than most alloys. The melting point, physical and mechanical properties of the composite at various temperatures determine the service temperature of composites. Most metals, ceramics and compounds can be used with matrices of low melting point alloys. The choice of reinforcements becomes more stunted with increase in the melting temperature of matrix materials. Figure 1.2 shows the preparation of metal composite.

### 1.2.3 Ceramic Matrix Composite

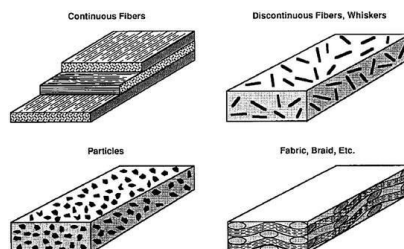


Figure 1.4 Preparation of Ceramic Matrix Composite

Ceramics can be described as solid materials which exhibit very strong ionic bonding in general and in few cases covalent bonding. High melting points, good corrosion resistance, stability at elevated temperatures and high compressive strength, render ceramic-based matrix materials a favourite for applications requiring a structural material that doesn't give way at temperatures High modulus of elasticity and low tensile strain, which most ceramics possess,

have combined to cause the failure of attempts to add reinforcements to obtain strength improvement. This is because at the stress levels at which ceramics rupture, there is insufficient elongation of the matrix which keeps composite from transferring an effective quantum of load to the reinforcement and the composite may fail unless the percentage of fiber volume is high enough. A material is reinforcement to utilize the higher tensile strength of the fiber, to produce an increase in load bearing capacity of the matrix. Addition of high-strength fiber to a weaker ceramic has not always been successful and often the resultant composite has proved to be weaker. The use of reinforcement with high modulus of elasticity may take care of the problem to some extent and presents pre-stressing of the fiber in the ceramic matrix is being increasingly resorted to as an option. When ceramics have a higher thermal expansion coefficient than reinforcement materials, the resultant composite is unlikely to have a superior level of strength. In that case, the composite will develop strength within ceramic at the time of cooling resulting in micro cracks extending from fiber to fiber within the matrix. Micro cracking can result in a composite with tensile strength lower than that of the matrix. Figure 1.3 shows the preparation of ceramic composite.

### 1.3 FIBER REINFORCED COMPOSITE

Fibers are the important class of reinforcements, as they satisfy the desired conditions and transfer strength to the matrix constituent influencing and enhancing their properties as desired. Glass fibers are the earliest known fibers used to reinforce materials. Ceramic and metal fibers were subsequently found out and put to extensive use, to render composites stiffer more resistant to heat. Fibers fall short of ideal performance due to several factors. The performance of a fiber composite is judged by its length, shape, orientation, and composition of the fibers and the mechanical properties of the matrix. The orientation of the fiber in the matrix is an indication of the strength of the composite and the strength is greatest along the longitudinal directional of fiber. This doesn't mean the longitudinal fibers can take the same quantum of load irrespective of the direction in which it is applied. Optimum performance from longitudinal fibers can be obtained if the load is applied along its direction. The slightest shift in the angle of loading may drastically reduce the strength of the composite. Unidirectional loading is found in few structures and hence it is prudent to give a mix of orientations for fibers in composites particularly where the load is expected to be the heaviest. Monolayer tapes consisting of continuous or discontinuous fibers can be oriented unidirectional stacked into plies containing layers of filaments also oriented in the same direction. More complicated orientations are possible too and nowadays, computers are used to make projections of such variations to suit specific needs.

In short, in planar composites, strength can be changed from unidirectional fiber oriented composites that result in composites with nearly isotropic properties. Properties of angle-ply composites which are not quasi-isotropic may vary with the number of plies and their orientations. Composite variables in such composites are assumed to have a constant ratio and the matrices are considered relatively weaker than the fibers. The strength of the fiber in any one of the three axes would, therefore be one-third the unidirectional fiber composite, assuming that the volume percentage is equal in all three axes. However, orientation of short fibers by different methods is also possible like random orientations by sprinkling on to given plane or addition of matrix in liquid or solid state before or after the fiber deposition. Even three-dimensional orientations can achieve in this way. There are several methods of random fiber orientations, which in a two-dimensional one, yield composites with one-third the strength of a unidirectional fiber-stressed composite, in the direction of fibers. In a 3- dimension, it would result in a composite with a comparable ratio, about less than one-fifth.

In very strong matrices, moduli and strengths have not been observed. Application of the strength of the composites with such matrices and several orientations is also possible. The longitudinal strength can be calculated on the basis of the assumption that fibers have been reduced to their effective strength on approximation value in composites with strong matrices and non- longitudinally orientated fibers. It goes without saying that fiber composites maybe constructed with either continuous or short fibers. Experience has shown that continuous fibers (or filaments) exhibit better orientation, although it does not reflect in their performance. Fibers have a high aspect ratio, i.e., their lengths being several times greater than their effective diameters. This is the reason why filaments are manufactured using continuous process. This finished filaments. Mass production of filaments is well known and they match with several matrices in different ways like winding, twisting, weaving and knitting, which exhibit the characteristics of a fabric. Since they have low densities and high strengths, the fiber lengths in filaments or other fibers yield considerable influence on the mechanical properties as well as the response of composites to processing and procedures. Shorter fibers with proper orientation composites that use glass, ceramic or multi-purpose fibers can be endowed with considerably higher strength than those that use continuous fibers. Short fibers are also known to their theoretical strength. The continuous fiber constituent of a composite is often joined by the filament winding process in which the matrix impregnated fiber wrapped around a mandrel shaped like the part over which the composite is to be placed, and equitable load distribution

and favourable orientation of the fiber is possible in the finished product. However, winding is mostly confined to fabrication of bodies of revolution and the occasional irregular, flat surface. Short-length fibers incorporated by the open- or close-mould process are found to be less efficient, although the input costs are considerably lower than filament winding. Most fibers in use currently are solids which are easy to produce and handle, having a circular cross-section, although a few non-conventional shaped and hollow fibers show signs of capabilities that can improve the mechanical qualities of the composites. Given the fact that the vast difference in length and effective diameter of the fiber are assets to a fiber composite, it follows that greater strength in the fiber can be achieved by smaller diameters due to minimization or total elimination of surface of surface defects. After flat-thin filaments came into vogue, fibers rectangular cross sections have provided new options for applications in high strength structures. Owing to their shapes, these fibers provide perfect packing, while hollow fibers show better structural efficiency in composites that are desired for their tiffness and compressive strengths. In hollow fibers, the transverse compressive strength is lower than that of a solid fiber composite whenever the hollow portion is more than half the total fiber diameter. However, they are not easy to handle and fabricate

## II. RELATED WORK

The main purpose of this chapter is to afford comprehensive information on the issues to be considered in this thesis and to investigate the mechanical and sound absorption properties of various natural fibers reinforced composites. This chapter is to provide a deep understanding of manufacturing methods and industrial applications of natural fibers reinforced composites. From the various literature the mechanical, sound absorption and morphological analysis of treated and untreated natural fiber reinforced composites are also discussed in the sub sequent section. The literature review for the present work was studied under the following titles.

1. Natural Fibers Reinforced Composites
2. Manufacturing Methods for Natural Fiber Reinforced Composites
3. Industrial Applications of Natural Fibers Reinforced Composites

### 2.1 Natural Fibers Reinforcement Composites

Sanjeev Kumar et al. (2010) reviewed in recent times, demand for light weight and high strength materials fabricated from natural fibres has increased tremendously. The use of natural fibres has rapidly increased due to their high availability, low density, and renewable capability over synthetic fibre. Natural leaf fibres are easy to extract from the plant (retting process is easy), which offers high stiffness, less energy consumption, less health risk, environment friendly, and better insulation property than the synthetic fibre-based composite. Natural leaf fibre composites have low machining wear with low cost and excellent performance in engineering applications, and hence established as superior reinforcing materials compared to other plant fibres.

In this review, the physical and mechanical properties of different natural leaf fibre-based composites are addressed. The influences of fibre loading and fibre length on mechanical properties are discussed for different matrices-based composite materials. The surface modifications of natural fibre also play a crucial role in improving physical and mechanical properties regarding composite materials due to improved fibre/matrix adhesion. Additionally, the present review also deals with the effect of silane-treated leaf fibre-reinforced thermoset composite, which play an important role in enhancing the mechanical and physical properties of the composites.

Md Syduzzaman et al. (2012) reviewed the increasing global environmental concerns and awareness of renewable green resources is continuously expanding the demand for eco-friendly, sustainable and biodegradable natural fibre reinforced composites (NFRCs). Natural fibres already occupy an important place in the composite industry due to their excellent physicochemical and mechanical properties. Natural fibres are biodegradable, biocompatible, eco-friendly and created from renewable resources. Therefore, they are extensively used in place of expensive and non-renewable synthetic fibres, such as glass fibre, carbon fibre and aramid fibre, in many applications. Additionally, the NFRCs are used in automobile, aerospace, personal protective clothing, sports and medical industries as alternatives to the petroleum-based materials. To that end, in the last few decades numerous studies have been carried out on the natural fibre reinforced composites to address the problems associated with the reinforcement fibres, polymer matrix materials and composite fabrication techniques in particular. There are still some drawbacks to the natural fibre reinforced composites (NFRCs)—for example, poor interfacial adhesion between the fibre and the polymer matrix, and poor mechanical properties of the NFRCs due to the hydrophilic nature of the natural fibres. An up-to-date holistic review facilitates a clear understanding of the behaviour of the composites along with the constituent materials. This article intends to review the research carried out on the natural fibre reinforced composites over the last few decades.

Furthermore, up-to-date encyclopaedic information about the properties of the NFRCs, major challenges and potential measures to overcome those challenges along with their prospective applications have been exclusively illustrated in this review work. Natural fibres are created from plant, animal and mineral-based sources.

The plant-based cellulosic natural fibres are more economical than those of the animal-based fibres. Besides, these pose no health issues, unlike mineral-based fibres. Hence, in this review, the NFRCs fabricated with the plant-based cellulosic fibres are the main focus.

## 2.2 Manufacturing Methods for Natural Fiber Reinforced Composites

Chun Lv et al. (2013) reviewed Both geopolymer and plant fiber (PF) meet the requirements of sustainable development. Geopolymers have the advantages of simple preparation process, conservation and environmental protection, high early strength, wide source of raw materials, and low cost. They have broad application prospects and are considered as the most potential cementitious materials to replace cement. However, due to the ceramic-like shape and brittleness of geopolymers, their flexural strength and tensile strength are poor, and they are sensitive to microcracks. In order to solve the brittleness problem of geopolymers, the toughness of composites can be improved by adding fibers. Adding fibers to geopolymers can limit the growth of cracks and enhance the ductility, toughness and tensile strength of geopolymers. PF is a good natural polymer material, with the advantages of low density, high aspect ratio.

It is not only cheap, easy to obtain, abundant sources, but also can be repeatedly processed and biodegradable. PF has high strength and low hardness, which can improve the toughness of composites. Nowadays, the research and engineering application of plant fiber-reinforced geopolymers (PFRGs) are more and more extensive. In this paper, the recent studies on mechanical properties of PFRGs were reviewed. The characteristics of plant fibers and the composition, structure and properties of geopolymers were reviewed. The compatibility of geopolymer material and plant fiber and the degradation of fiber in the substrate were analyzed. From the perspective of the effect of plant fibers on the compression, tensile and bending properties of geopolymer, the reinforcing mechanism of plant fibers on geopolymer was analyzed. Meanwhile, the effect of PF pretreatment on the mechanical properties of the PFRGs was analyzed. Through the comprehensive analysis of PFRGs, the limitations and recommendations of PFRG are put forward.

Agnivesh Kumar Sinha et al. (2015) studied the mechanical properties of natural fibre polymer composites. Extensive efforts have been made in the last decade for the development of natural fibre composites. This development paved the way for engineers and researchers to come up with natural fibre composites (NFCs) that exhibit better mechanical properties. The present review is based on the mechanical properties of jute, abaca, coconut, kenaf, sisal, and bamboo fibre-reinforced composites. Before selecting any NFC for a particular application, it becomes necessary to understand its compatibility for the same, which can be decided by knowing its mechanical properties such as tensile, flexural, and impact strengths. This review paper emphasises on the factors influencing the mechanical properties of NFCs like the type of matrix and fibre, interfacial adhesion, and compatibility between matrix and fibre.

Efforts are also made to unveil the research gaps from the past literatures, as a result of which it is inferred that there is very limited work published in the field of vibration incorporating potential fillers such as red mud and fly ash with NFCs.

Binu kumar (2017) studied the mechanical properties of composite is a material fabricated by combining matrix with reinforcement. Matrix is the major portion and reinforcement is the minor portion in the composites. Further, matrix is continuous phase and the reinforcement is the discontinuous phase which dispersed in the matrix. Composite materials are gaining increased interest among the industrialists and material scientist because of its high strength to weight ratio, no harm to environment, low cost and ease of availability. Owing to the feasible properties, composites are applicable in the structural work to replace the conventional material without affecting the strength. Hybrid composite is similar to composite in which two or more reinforcement is used to satisfy the drawback one reinforcement. It provides uniform strength to the composite in all directions. Hybrid composite is superior to conventional composite because of the high strength and high resistance against water absorption and thickness swelling. The final property of hybrid composite differs from the properties of constituent elements. Neem fiber is a natural fiber extracted from the stem of Neem tree. Neem fibers are used as herbals and pesticides in the medical and agricultural fields. Banana fiber is extracted from the banana plant which is the strongest fiber among the natural fibers. In this investigation, hybrid composites have been fabricated using Neem and Banana fibers by hand layup technique. Three types of composites viz. B:N (1:4), B:N (1:1) and B:N (4:1) were prepared. Fibers were treated with chemicals before processing. Mechanical properties of treated and untreated composites were tested. The effect of chemical treatment, moisture absorption and fiber loading on the mechanical behavior of the composites were analyzed.

### 2.3 Industrial Applications of Natural Fibers Reinforced Composites

Raja T et al. (2018) studied the mechanical properties of moisture behaviour of neem/banyan fibres reinforced with polymer matrix hybrid composite. In this research work, chopped neem fibre and woven banyan fibre were stacked into seven different sequences and fabricated by the hand lay-up technique. The laminates consist of 70% epoxy matrix, 25% natural fibre reinforcements and 5% sawdust filler material. The mechanical properties of the composite such as tensile strength, flexural strength, compression strength and impact strength were studied and also identify the water absorption capacity under different weight fractions of fibres. It is more effective by increasing the weight fraction of bi-directional woven banyan fibres which give better tensile strength of 25.55 MPa, flexural strength of 21.23 MPa, compression strength of 25.21 MPa and increasing of chopped neem fibre gave higher impact strength of 18 J in sample G was found in natural composite. Also, in sample G was given less moisture absorption capacity of 0.1% compared with other sample of hybrid composite. Therefore, the sample G sequence can replace to polycarbonate synthetic helmet and it is a potential alternate material for making natural composite helmet. The surface morphology was studied by SEM analysis before and after fracture of the hybrid composite to reveal the surface finish and failure mode of the epoxy composite laminates.

Thandavamoorthy Raja et al. (2019) studied the reinforced with neem and banyan fiber particulate epoxy hybrid composite a awareness of environmental concerns influences researchers to develop an alternative method of developing natural fiber composite materials, to reduce the consumption of synthetic fibers. This research attempted testing the neem (*Azadirachta indica*) fiber and the banyan (*Ficus benghalensis*) fiber at different weight fractions, under flame retardant and thermal testing, in the interest of manufacturing efficient products and parts in real-time applications. The hybrid composite consists of 25% fiber reinforcement, 70% matrix material, and 5% bran filler. Their thermal properties—short-term heat deflection, temperature, thermal conductivity, and thermal expansion—were used to quantify the effect of potential epoxy composites. Although natural composite materials are widely utilized, their uses are limited since many of them are combustible. As a result, there has been a lot of focus on making them flame resistant. The thermal analysis revealed the sample B was given 26% more short-term heat resistance when the presence of banyan fiber loading is maximum. The maximum heat deflection temperature occurred in sample A (104.5 °C) and sample B (99.2 °C), which shows a 36% greater thermal expansion compared with chopped neem fiber loading. In sample F, an increased chopped neem fiber weight fraction gave a 40% higher thermal conductivity, when compared to increasing the bidirectional banyan mat of this hybrid composite. The maximum flame retardant capacity occurred in samples A and B, with endurance up to 12.9 and 11.8 min during the flame test of the hybrid composites.

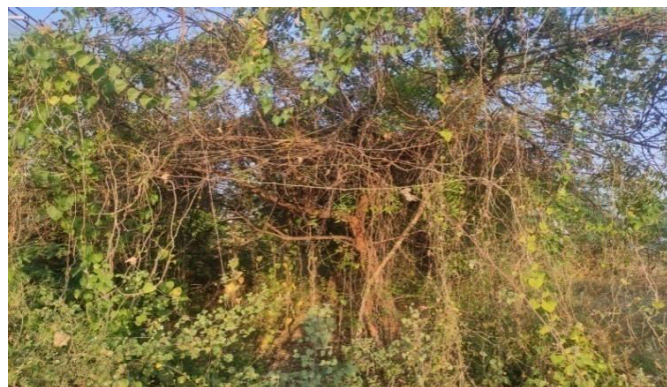
## III. METHODOLOGY

### 3.1 MATERIAS REQUIRED

CAREX LASIOCARPA FIBER

EPOXY RESIN

#### 3.1.1 Carex Lasiocarpa Fiber



**Figure 3.1 Carex Lasiocarpa Fiber**

Growing environmental concerns, issues and challenges has led to the development of various natural resources product in several applications in our day today's life. One of the important application is the development of natural

fibers in the field of advance technical textiles as the fibers shows specific properties, cost-effectiveness, biodegradability and recyclability. The use of traditional medicinal plants for fiber extraction has been observed for various textile applications. The neem tree, scientifically known as *Azadirachta indica*, which is widely grown in India, is one of the most important tree that constitutes several phytoconstituents and numerous pharmacological activities present in it. It is a fast growing tree which belong to the family of Mahogany. The branches are wide spread. The twigs of neem are used by the rural people and villagers for brushing their teeth as it has several beneficial properties. It is said that a large number of compounds have been separated and isolated from various part of the neem plant. The neem twigs have fibrous substances associated in it.

The increasing demand in global textiles competition has led the researchers to face challenges and develop a wide range of commercial textile products.

A medicinal plant which is scientifically known as *Azadirachta indica*, a native to Indian subcontinent have several benefits. The plant has enormous applications as it has number of properties like anti-allergic, insecticidal, anti-inflammatory, anti-ulcer, anti-pyorrhoeic, antiscabic and other natural biological activities. As it possess many properties, it is often called as “Divine Tree” and “Heal All” in India. It has been used extensively in the treatment of a variety of diseases as well as in the ayurvedic applications. *Azadirachta indica* is considered to be native to the Indian region and Bangladesh in the Indian subcontinent and to Cambodia, Laos, Myanmar, Thailand and Vietnam in Indochina. It has been widely introduced elsewhere in tropical and subtropical regions, from South America to Indonesia.

The margosa tree is noted for its drought resistance. Normally it thrives in areas with sub-arid to sub-humid conditions, with an annual rainfall of 400– 1,200 mm (16–47 in). It can grow in regions with an annual rainfall below 400 mm, but in such cases it depends largely on ground water levels. Margosa can grow in many different types of soil, but it thrives best on well drained deep and sandy soils. It is a typical tropical to subtropical tree and exists at annual mean temperatures of 21–32 °C (70–90 °F). It can tolerate high to very high temperatures and does not tolerate temperature below 5 °C (41 °F). Margosa is one of a very few shade-giving trees that thrive in drought-prone areas e.g. the dry coastal, southern districts of India and Pakistan. The trees are not at all delicate about water quality and thrive on the merest trickle of water, whatever the quality. In India and tropical countries where the Indian diaspora has reached, it is very common to see margosa trees used for shade lining streets, around temples, schools and other such public buildings or in most people's back yards. In very dry areas the trees are planted on large tracts of land. Margosa leaves are dried in India and placed in cupboards to prevent insects eating the clothes, and also in tins where rice and wheat is stored. The flowers are also used in many Indian festivals like Ugadi. Association with Hindu festivals in India.

### Traditional medicine

Products made from margosa trees have been used in the traditional medicine of India for centuries, for treating skin troubles and rheumatism, but there is insufficient clinical evidence to indicate any benefits of using margosa for medicinal purposes. In adults, no specific doses have been established, and short-term use of margosa appears to be safe, while long-term use may harm the kidneys or liver in small children, margosa oil is toxic and can lead to death. Margosa may also cause miscarriages, infertility, and low blood sugar. In Southern India and the Middle-East, neem twigs are often used as a teeth- cleaning twig.

### Pest and disease control

Margosa is a key ingredient in non-pesticidal management (NPM), providing a natural alternative to synthetic pesticides. Margosa seeds are ground into powder that is soaked overnight in water and sprayed on the crop. To be effective, it must be applied repeatedly, at least every ten days. Margosa does not directly kill insects. It acts as an anti-feedant, repellent, and egg-laying deterrent and thus protects the crop from damage. The insects starve and die within a few days. Margosa also suppresses the subsequent hatching of their eggs. Margosa- based fertilizers have been effective against southern armyworm. Margosa cake may be used as a fertilizer. Margosa oil has been shown to avert termite attack as an ecofriendly and economical agent.

### Margosa oil for polymeric resins

Applications of margosa oil in the preparation of polymeric resins have been documented in recent reports. The synthesis of various alkyd resins from margosa oil is reported using a monoglyceride (MG) route and their utilization



for the preparation of PU coatings. The alkyds are prepared from reaction of conventional divalent acid materials like phthalic and maleic anhydrides with MGof margosa oil.

### Other Uses

- └┘ Tree the margosa tree is of great importance for its anti- desertification properties and possibly as a good carbon dioxide sink. It is also used for maintaining soil fertility.
- └┘ Fertilizer neem extract is added to fertilizers (urea) as a nitrification inhibitor.
- └┘ Animal feed margosa leaves can be occasionally used as forage for ruminants and rabbits.
- └┘ Teeth cleaning margosa has traditionally been used as a type of teeth- cleaning twig.



Figure 3.2 First stage of fiber material

### 3.1.2 Epoxy Resin



Figure 3.3 Epoxy Resin – LY556

Epoxy Resin-LY556 is either any of the basic components or the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as polyepoxides, are a class of reactive prepolymers and polymers which contain epoxide groups.

Epoxy Resins-LY556 may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (usually called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing.

Reaction of polyepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with favorable mechanical properties and high thermal and chemical resistance. Epoxy has a wide range of applications, including metal coatings, use in electronics/electrical components/LEDs, high tension electrical insulators, paint brush manufacturing, fiber-reinforced plastic materials and structural adhesives. Epoxy is sometimes used as a glue.

#### a. Applications

The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fiber and fiberglass reinforcements (although polyester, vinyl ester, and other thermosetting resins are also used for glass-reinforced plastic). The chemistry of epoxies and the range of commercially available variations allows cure polymers to be produced with a very broad range of properties. In general, epoxies are

known for their excellent adhesion, chemical and heat resistance, good-to-excellent mechanical properties and very good electrical insulating properties. Many properties of epoxies can be modified (for example silver-filled epoxies with good electrical conductivity are available, although epoxies are typically electrically insulating). Variations offering high thermal insulation, or thermal conductivity combined with high electrical resistance for electronics applications, are available.

As with other classes of thermoset polymer materials, blending different grades of epoxy resin-LY556, as well as use of additives, plasticizers or fillers is common to achieve the desired processing or final properties, or to reduce cost. Use of blending, additives and fillers is often referred to as formulating.

### 3.2 MANSION WAX



Figure 3.4 Mansion Wax Polish

Mansion wax polish gives an instant shine to the surface. This wax polish protects wood and a range of other materials. Its easy application gives high performance for long-lasting protection & ultimate shine to any surface, such as granite, marble, concrete, wood furniture and fibreglass (FRP) products. Mansion wax polish gives a new and bright look and helps hide the scratches on the surfaces.

1. **Polishing Abrasive** Mansion wax polish is a high quality surface wax that protects & gives an instant shine to surfaces
2. **Ultimate Shine** This wax polish provides the surface its used on with long lasting shine and gives a bright & new look to it
3. **High Performance Protection** Mansion wax polish provides long lasting protection to surfaces & helps in hiding scratches on the surface
4. **Multi Surface Wax** It can be used on multiple surfaces to give them a long lasting shine & protection, it's suitable for granite, marble, concrete, wood furniture, fibreglass products, floors & lot more
5. **Directions to Use** Apply a thin coat of the wax with a cloth after dusting & cleaning the surface. Shine with a clean soft cloth, to get a clean & shiny surface repeat the steps daily till achieved Wax polish is a wood polish obtained by dissolving paraffin, ceresin, Montana, and beeswax in turpentine or naphtha oil. It is one of the natural and effective methods used to protect and renew wooden products. It is common to apply by dipping method. Mansion wax polish is also used for providing protection to the wood and a range of other materials. These polishes are available in a wide range of colors and they give a new and bright look to the wood and help in hiding the scratches which are these on the surfaces. The Mansion Wax Polish is highly demanded and acclaimed in the market owing to its longer shelf life, purity, remarkable quality, durability, accurate composition, stability and effectiveness. Moreover, we provide these wax polishes in diverse packing options as per the demands and requirements of our valuable clients.

### 3.3 FIBER EXTRACTION PROCESS

1. Place the DRY FIBER materials one plate in both Horizontal direction, Vertical direction and Random Direction
2. Pouring the EPOXY RESIN LY556 by extension of fiber material in the center of the plate sample.

### 3.4 Preparation of Mould



Figure 3.5 Prepare the EPOXY(250g to 280 g)/plate, Hardner 10%/plate and Mansion Wax Polish



Figure 3.6 Weighing Machine



Figure 3.7 Plate size 3mm\*3mm



Figure 3.8 Cut the fiber length upto 30cm



Figure 3.9 (a) Apply the Epoxy Resin in working plate



Figure 3.9 (b) Apply the wax into fiber plate



Figure 3.10 Hand Layup Moulding Preparation

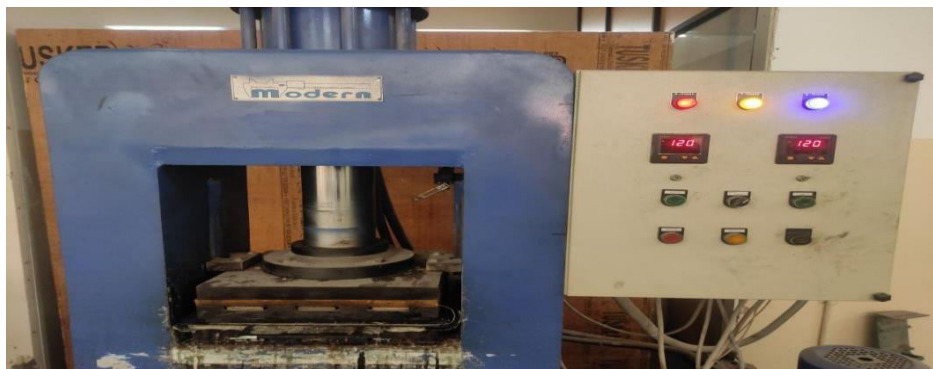


Figure 3.11 Compression Moulding (compress the plate in 2 to 3 hrs)



Figure 3.12 Fabricated composite material



Figure 3.13 Jig Saw Plate cutting

### 3.5 Plate preparation

First plate: obtain the fiber from the plant and remove the skin in the fiber. To dry the fiber in the sunlight per day. fiber length up to 30cm. Add the resin in the plate (250g) and hardener 10%. After place the plate in the compression moulding up to 2 to 3 hrs. place the fiber in the plate to uni directional direction.

Second plate: obtain the fiber from the plant and remove the skin in the fiber. To dry the fiber in the sunlight per day. fiber length up to 30cm. Add the resin in the plate (250 grams) and hardener 10%. After place the plate in the compression moulding up to 2 to 3 hrs. place the fiber in the plate in 45 degree angle direction.



Third plate: obtain the 150 gram fiber from the plant.Remove the skin and stem in the fiber.To dry the fiber in the sunlight per day.fiber length up to 30cm.Add the resin in the plate(250 grams) and hardner 10%.After place the platein the compression moulding up to 2 to 3 hrs.place the fiber in the plate( randomdirection).

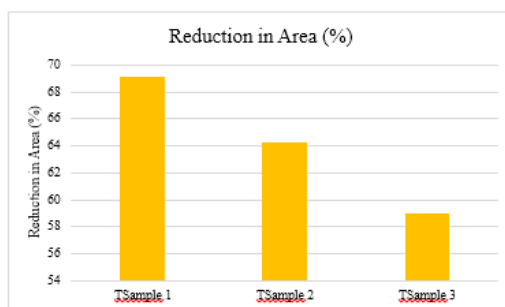
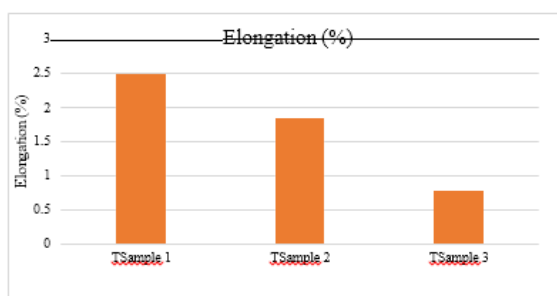
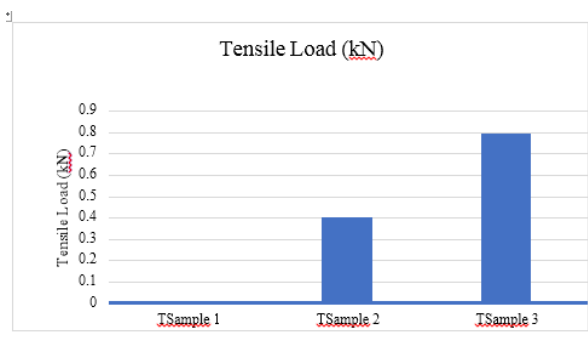
#### IV. EXPERIMENTAL RESULTS

##### TENSILE STRENGTH OF COMPOSITES

The composite specimens are tested for tensile properties in universal testing machine and obtained tensile strength are shown in the below figure. The value of tensile strength obtained is depicted.

TEST	TENSILE LOAD (kN)	ELONGATION (%)	REDUCTION AREA (%)
TSAMPLE 1	0.01	2.50	69.17
TSAMPLE 2	0.43	1.85	64.29
TSAMPLE 3	0.79	0.77	59.06

##### TENSILE GRAPH DAIGRAM



#### V. CONCLUSION

As a natural fiber, CAREX LASIOCARPA offers an eco-friendly alternative to synthetic fibers. In the present study, the natural fillers are added with the prescribed weight ratio to the CAREX LASIOCARPA fiber composite and its mechanical characteristics are analyzed by the same testing procedure and by comparing the obtained results, the better material composition is finalized.

The experimental study on the composite with natural fillers on physical, tensile, hardness, impact, compression and mechanical behaviour test leads to the following conclusions. From the tensile results, it is found that pure fiber sample have withstood a maximum tensile load of 0.79 kN. However, the smashed fiber sample have yielded maximum % of elongation and reduction in area of 2.5 % and 69.17 % respectively. From the hardness results, it is found that pure fiber sample have withstood a maximum pressure load of 58MPa. However, the smashed fiber sample have test location in the sample area of 68% and 70% respectively. From the impact results, it is found that pure fiber sample have withstood a sudden load of 1.001 J. However , the smashed fiber sample have the Joule(J/cm<sup>2</sup>) area 0.74 respectively. From the compression results, it is found that pure fiber sample have withstood a maximum peak load of 1.01 kN. However, the smashed fiber sample have yielded maximum % of elongation and reduction in area of 8.564% and 4.02% respectively.

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